Comments on "Interference phenomena in the $J^p = 1/2^-$ - wave in η photoproduction" by A.V. Anisovich, E. Klempt, B. Krusche, V.A. Nikonov, A.V. Sarantsev, U. Thoma, D. Werthmuller, arXiv:1501.02093v1 [nucl-ex].

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The authors of Ref. [1] claimed that " ... narrow structure observed in the excitation function of $\gamma n \to \eta n$ can be reproduced fully with a particular interference pattern in the $J^p = 1/2^-$ partial wave..." while a narrow structure in Compton scattering off the neutron is "...a stand-alone observation unrelated to the structure observed in $\gamma n \to \eta n$...". The source for the second statement may be a simple numerical error. If so, the interpretation of the narrow structure in $\gamma n \to \eta n$ as interference effects in the $J^p = 1/2^-$-wave and some conclusions from Ref. [1] are questionable.

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The observation of a narrow enhancement at $W \sim 1.68$ GeV in η photoproduction [2–5] and Compton scattering off the neutron [6] (the so-called "neutron anomaly") raised intensive debates about its nature. One possible explanation is a signal of a nucleon resonance with unusual properties: the mass near $M \sim 1.68$ GeV, the narrow ($\Gamma \leq 25$ MeV) width, the strong photoexcitation on the neutron, and the suppressed decay to πN final state. A new one-star $N^*(1685)$ resonance was included into the listing of the Particle Data Group [7].

On the other hand, several groups tried to explain the bump in the $\gamma n \to \eta n$ cross section in terms of the interference of well-known wide resonances. The recent attempt was done in Ref. [1]. The authors concluded that it can be full explained by the interference of well-known resonances while the inclusion of $N^*(1685)$ only deteriorates the data fit.

One major challenge for this interpretation is the observation of a narrow peak at the same energy in Compton scattering on the neutron at GRAAL [6]. The authors of Ref. [1] estimated the total cross section of $N^*(1685)$ in $\gamma n \to \gamma n$ assuming the mass $M = 1670$ MeV, the width $\Gamma_{tot} = 30$ MeV, and (*a priori*) the quantum numbers P_{11}. The result $\sigma_{res} = 10.8$ pb led to a conclusion that "...this value is far below the sensitivity of the GRAAL experiment. If it is not a statistical fluctuation, ... it is a stand-alone observation unrelated to the structure observed in $\gamma n \to \eta n$...".

Unfortunately, there might be a simple numerical error: if to check Eq.(1) from Ref. [1], the correct number is $\sigma_{res} = 10.8$ nb (i.e. 1000 times larger).

Even this number may be pessimistic. The results from GRAAL and CBELSA/TAPS suggest $\Gamma_{tot} \leq 25$ MeV. If to set $\Gamma_{tot} = 20$ MeV then $\sigma_{res} = 24.3$ nb. If in addition to assume that $N^*(1685)$ is a higher-spin resonance, σ_{res} may be significantly larger.

The peak in $\gamma n \to \gamma n$ at GRAAL was observed at 157°. The measured differential cross section of Compton scattering on the proton at 160° and $E_\gamma = 1.025$ GeV is 27.1 ± 5.4 nb/str [8]. In accordance with dispersion-relation calculations [9] Compton cross section on the neutron (without narrow resonance) at 160° and $E_\gamma = 1$ GeV may be significantly (~ 5 times) smaller than that on the proton. The peak of $N^*(1685)$ on the top of the flat $\gamma n \to \gamma n$ cross section could and, if $N^*(1685)$ does exist, should be seen at GRAAL.

The observation of the peak in Compton scattering at the same energy as in $\gamma n \to \eta n$ challenges the explanation of the neutron anomaly in terms of interference effects. The specific interference of wide resonances cannot generate a narrow peak in η photoproduction which is governed by only isospin-1/2 resonances, simultaneously generate a peak at the same energy in Compton scattering which governed by both isospin-1/2 and isospin-3/2 resonances, and generate neither of peak in $\gamma n \to \pi^0 n$ which is governed by the same resonances as Compton scattering.

At present, the only available explanation is the existence of $N^*(1685)$.

[1] by A.V. Anisovich, E. Klempt, B. Krusche, V.A. Nikonov, A.V. Sarantsev, U. Thoma, D. Werthmuller, arXiv:1501.02093v1 [nucl-ex].
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